



National Unit Specification: general information

UNIT Engineering: Process Control (SCQF level 6)

CODE F5KK 12

SUMMARY

This Unit can be developed as part of a National Qualification Group Award but can also be taken as a free-standing Unit. This Unit is designed to enable candidates to develop knowledge and understanding of process control as used in process industries.

Candidates will develop knowledge and understanding of process control systems, on/off control, the operating and performance characteristics of proportional control and control valves.

This Unit is suitable for candidates who wish to progress to further education or who wish to become employed as technicians in this sector.

Candidates will also develop knowledge and skills in setting up and operating a single loop proportional control system.

OUTCOMES

- 1 Explain the operation of process control systems.
- 2 Apply the characteristics of a proportional controller, and produce a graph from the data.
- 3 Explain the construction and operating characteristics of control valves.
- 4 Set up and operate a single loop proportional control system.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

- ◆ Standard Grade Mathematics — General/Credit Level
- ◆ Standard Grade Technological Studies and/or science subjects — General/Credit Level

Administrative Information

Superclass: VE

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CREDIT VALUE

1 credit at SCQF level 6 (6 SCQF credit points at SCQF level 6*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

CORE SKILLS

There is no automatic certification of Core Skills in this Unit.

This Unit provides opportunities for candidates to develop aspects of the following Core Skills:

Problem Solving	(SCQF level 6)
Numeracy	(SCQF level 6)
Information Technology	(SCQF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

National Unit Specification: statement of standards

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Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit Specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

OUTCOME 1

Explain the operation of process control systems.

Performance Criteria

- (a) The operating cycles of open and closed loop systems for on/off and continuous control actions are explained correctly.
- (b) The schematic and block diagrams of on/off and continuous control systems are explained correctly.
- (c) The system input and output signal ranges are explained correctly.

OUTCOME 2

Apply the characteristics of a proportional controller, and produce a graph from the data.

Performance Criteria

- (a) The input and output characteristics of a proportional controller with respect to gain and proportional band are applied correctly.
- (b) Produce a graph from experimental data with respect to proportional band/gain settings.

OUTCOME 3

Explain the construction and operating characteristics of control valves.

Performance Criteria

- (a) A control valve and the operation of the component parts are explained correctly.
- (b) The fail-safe operation of control valves is explained correctly.
- (c) The flow/lift characteristics of a control valve is explained correctly.

OUTCOME 4

Set up and operate a single loop proportional control system.

Performance Criteria

- (a) The connections of a single loop proportional control system are identified correctly.
- (b) The components of a single loop proportional control system are set up correctly.
- (c) The effect of set point and process value (load) changes are correctly recorded.
- (d) The effect of gain/proportional band changes on the system offset, initial rate of change and stability are correctly recorded.

National Unit Specification: statement of standards (cont)

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EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written and/or oral evidence is required which demonstrates that the candidate has achieved Outcomes 1, 2 and 3 to the standard specified in the Outcome and Performance Criteria. The evidence should be obtained in a combined assessment carried out under controlled, supervised conditions. The assessment will be closed-book and should last approximately 1 hour.

Performance evidence, supplemented with an assessor observation checklist and written and/or oral evidence is required which demonstrates that the candidate has achieved Outcome 4 to the standard specified in the Outcome and Performance Criteria. The candidate will make set point and process value (load) changes for three gain/proportional band settings. The evidence for this Outcome should be obtained under controlled, supervised conditions. An assessor observation/checklist should record the correct set up and operation of the control loop and test equipment. The assessment for this Outcome should be carried out towards the end of the Unit.

The Assessment Support Pack for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the assessment support pack to ensure a comparable standard.

National Unit Specification: support notes

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This part of the Unit Specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

This Unit is a restricted core Unit within the National Certificate Group Award in Measurement and Control Engineering, but is also suitable for candidates wishing to study the Unit on a free-standing basis.

This Unit has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas:

Outcome 1

- ◆ Examples of typical processes eg pressure, temperature, level and flow
- ◆ Automatic and manual modes of operation
- ◆ Open loop systems (manual)
- ◆ Closed loop on/off (2-step) control loops (automatic)
- ◆ Closed loop continuous control loops (automatic)
- ◆ Schematic diagrams of typical systems
- ◆ Block diagrams of typical systems
- ◆ System inputs and typical ranges
- ◆ System outputs and typical ranges
- ◆ Standard terms eg set point, process value (measured value) and error

Outcome 2

- ◆ Proportional control action
- ◆ Measured value, set point and error
- ◆ Bias
- ◆ Gain/proportional band
- ◆ Relationship between gain and proportional band
- ◆ Direct and reverse controller action
- ◆ Final control element
- ◆ Automatic and manual control modes

Outcome 3

- ◆ Need for a control valve
- ◆ Types eg globe, butterfly, gate and ball
- ◆ Actuators (diaphragm, piston, motorised)
- ◆ Parts of valve (actuator, stem, seal, trim, plug, seat, body, packing gland etc)
- ◆ Operation of control valves
- ◆ Fail-safe operation
- ◆ Flow/lift characteristics eg equal percentage, linear, quick opening

National Unit Specification: support notes (cont)

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Outcome 4

- ◆ Connections required for a control loop
- ◆ Input and output signal ranges
- ◆ Effect of set point changes
- ◆ Effect of load changes
- ◆ Effect of gain/proportional band changes
- ◆ Automatic/manual changeover and bumpless transfers
- ◆ Performance characteristics eg offset, initial rate of change and stability

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

This Unit should be delivered in a way that includes a mixture of lecturer led and candidate-centred activities. This would include practical activities and self study for candidates. It is recommended that this Unit is delivered at the start of the award and before the Unit *Engineering: Process Control Systems*.

The use of ICT (Information and Communication Technology) should be used to support the delivery of this Unit. This could take the form of candidates researching different types of process control systems/equipment etc. on the internet. Computer simulation packages could also be used.

The Unit requires access to a measurement and control engineering laboratory with a range of process control systems and test equipment. Demonstrations and laboratory exercises can be used to improve the candidates understanding of process control. This will help to relate theory to practice.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Aspects of the Core Skill of *Problem Solving*, that is, critical thinking, planning and organising, reviewing and evaluating, will be naturally developed in this Unit, which requires application of knowledge to a practical task. Candidates identify and explain significant factors relevant to process and control systems before they setup and safely operate a single loop proportional control system. Demonstration and discussion of process control test equipment during formative work would be particularly useful in supporting analytical evaluation or developing analytical evaluation of the work.

Aspects of the Core Skill of *Numeracy* and *Information Technology* are developed in this Unit. Accuracy in interpreting and applying complex graphic information and the ability to calculate, and present numerical data underpins the competencies developed in the Unit. Candidates should be provided with formative opportunities to work with graphs and diagrams contextualised to engineering applications. Researching background technical information on line would develop confidence and skill in the use of technology. Computer simulation packages could also be used. Candidates should be made aware of the effective and responsible use of equipment and software.

National Unit Specification: support notes (cont)

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by information and communications technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003)*, *SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Achievement of this Unit requires the Evidence Requirements for each Outcome to be met. A candidate who does not initially achieve the specified standard can have a further opportunity, attempting only the Outcome(s) not previously achieved.

Assessment for Outcomes 1, 2 and 3 could take the form of a written and/or oral assessment in which the candidate is given schematic and block diagrams of both a continuous and an on/off control system and asked to explain the operating cycles of both processes and identify input and output signal ranges on the diagrams. For Outcome 1 the candidate could explain the operation of an open loop system.

For Outcome 2, the candidate could be given a table of inputs and outputs and could complete the table by adding the gain and proportional band for each setting. The candidate could also produce a graph of the results and a short report on how to calculate the gain and the proportional band and the relationship between the two.

For Outcome 3 the candidate could be given a diagram of a control valve and asked to identify the parts and explain the operation of the parts. The candidate could also be given a graph of flow/lift characteristics and asked to explain the different characteristics.

The assessment for Outcome 4 is a practical assignment. The candidate could be given a working control loop, to produce a block diagram of the system identifying the input and output connections. The candidate could make set point, load and gain/proportional band changes and record the effect these have on the operation of the loop. A short report could be produced explaining the effect of the changes on the loop operation.

CANDIDATES WITH DISABILITIES AND/OR ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (www.sqa.org.uk).